

**WHAT IS CLAIMED:**

- 1     1.     Digital tone controls comprising:  
2             a first path including a digital filter and a scaler  
3     for controlling a level of a low frequency component of a  
4     received digital audio signal;  
5             a second path including a digital filter and a scaler  
6     for controlling a level of a high frequency component of the  
7     received digital audio signal;  
8             a third path including a scaler for controlling a level  
9     of an unfiltered component of the received audio signal; and  
10            a summer for adding a contribution from each of the  
11     paths to generate a composite signal having a selected gain  
12     - frequency response.
- 1     2.     The digital tone controls of Claim 1 wherein the  
2     digital filters comprise a infinite impulse response  
3     filters.
- 1     3.     The digital tone controls of Claim 1 wherein the  
2     digital filters comprise finite impulse response filters.
- 1     4.     The digital tone controls of Claim 1 wherein the  
2     filters and scalers are implemented in software.
- 1     5.     The digital tone controls of Claim 1 wherein the  
2     filters and scalers are implemented in software executed on  
3     a digital signal processor.



6 8. A method of controlling tonal level in a digital audio  
7 data stream comprising the steps of:  
8 filtering the audio data stream with a plurality of  
9 digital filler to extract a plurality of frequency  
10 components of a selected set of frequency bands;  
11 selectively scaling each of the frequency components;  
12 scaling an unfiltered component of the digital audio  
13 data stream; and  
14 summing the scaled frequency components with the scaled  
15 digital audio data stream to generate a digital signal  
16 having a selected frequency response.

1 9. The method of Claim 8 wherein said step of filtering  
2 comprises the substeps of:  
3 filtering the audio data stream with a bass low pass  
4 filter passing frequencies below a first corner frequency;  
5 filtering the audio data stream with a treble low pass  
6 filter passing frequencies below a second corner frequency,  
7 the second corner frequency being higher in frequency than  
8 the first corner frequency;  
9 filtering the audio data stream with a bass high pass  
10 filter passing frequencies above a third corner frequency;  
11 and  
12 filtering the audio data stream with a treble high pass  
13 filter passing frequencies above a fourth corner frequency,  
14 the fourth corner frequency being higher in frequency than  
15 the third corner frequency.

1 10. The method of Claim 8 wherein said step of filtering  
2 comprises the step of filtering the audio data stream using  
3 software filters.

4 11. The method of Claim 8 wherein said step of filtering  
5 comprises the step of filtering the audio data stream with a  
6 first order digital filter.

1 12. The method of Claim 8 wherein said step of filtering  
2 comprises the step of extracting each frequency component  
3 with an infinite impulse response filter.

4 13. The method of Claim 8 wherein said step of filtering  
5 comprises the step of extracting each frequency component  
6 with a finite impulse response filter.

1 14. The method of Claim 13 wherein the finite impulse  
2 response filter is of a 2nd order or greater.

1 15. The method of Claim 13 wherein the scalars take on  
2 positive values only.

1    ~~16.~~ An audio processing device comprising:  
2        a port for receiving a stream of audio data; and  
3        a digital signal processor operable to:  
4            filter out and scale a low frequency component of  
5        a data stream extracted from said received stream of  
6        audio data;  
7            filter out and scale a high frequency component of  
8        the extracted data stream;  
9            scale an unfiltered component of the extracted  
10       data stream; and  
11           adding the scaled low and high frequency  
12       components and the scaled unfiltered component of the  
13       extracted data stream to generate a composite signal  
14       having a selected gain - frequency response.

1    17. The audio processing device of Claim 16 wherein said  
2       digital signal processor comprises a selected one of a  
3       plurality of digital signal processors forming an audio  
4       decoder.

1    18. The audio processing device of Claim 16 wherein said  
2       digital signal processor is operable to execute program code  
3       implementing infinite impulse response filters for filtering  
4       out said low and high frequency components of said  
5       extracted data stream.

1 19. The audio processing device of Claim 16 wherein said  
2 digital signal processor is operable to execute program code  
3 implementing finite impulse response filters for filtering  
4 out said low and high frequency components of said  
5 extracted data stream.

1 20. The audio processing device of Claim 16 wherein said  
2 digital signal processor is operable to execute program code  
3 implementing multipliers for scaling said components of said  
4 extracted data stream.

1 21. The audio processing device of Claim 16 wherein said  
2 received audio data stream comprises a compressed audio data  
3 stream and said extracted data stream extracted from said  
4 received data stream comprises a stream of PCM data.

1 22. The audio processing device of Claim 16 wherein said  
2 received audio data stream comprises a uncompressed data  
3 stream and said extracted date stream comprises a stream of  
4 PCM data.

1    ~~23~~. A program for implementing tone controls in a  
2    programmable audio processing device comprising:  
3        a plurality of digital filters having programmable  
4        coefficients for extracting a plurality of frequency  
5        components from a digital audio data stream;  
6        a plurality of programmable scalers each for  
7        selectively setting an amplitude of one of the frequency  
8        components output from a corresponding digital filter; and  
9        a summer for summing scaled frequency components output  
10    from the programmable scalers.

1    24. The program of Claim 23 and further comprising a  
2    programmable scaler for selectively setting an amplitude of  
3    an unfiltered component of the digital data stream and  
4    selectively passing a scaled unfiltered component to the  
5    summer for summation with the scaled extracted frequency  
6    components.

1    25. The program of Claim 23 wherein the coefficients are  
2    selected to extract at least one bass component and at least  
3    one treble component from the audio data stream.

1 26. The program of Claim 23 wherein the coefficients are  
2 selected to provide a plurality of filters including:  
3 a bass low pass filter extracting frequencies below a  
4 selected bass frequency;  
5 a bass high pass filter for extracting frequencies  
6 above a selected bass frequency;  
7 a treble low pass filter for extracting frequencies  
8 below a selected treble frequency; and  
9 a treble high pass filter for extracting frequencies  
10 above a selected treble frequency.

1 27. The program of Claim 23 wherein the digital filters are  
2 first order.

3 28. The program of Claim 23 wherein the digital filters are  
4 second order or higher.

1 29. The program of Claim 23 wherein the digital filters are  
2 IIR filters.

1 30. The program of Claim 23 wherein the digital filters are  
2 FIR filters.